

## **SECTION 559 PILING**

**559.01 DESCRIPTION.** This work is the furnishing and placing of timber, steel, concrete, and other pile types.

**559.02 MATERIALS.** Furnish materials meeting the following Section and Subsection requirements:

Treated and Untreated Timber Piles .....	706.05
Structural Steel Piles .....	711.10.1
Steel Pipe Piles .....	711.10.2
Precast Concrete Piles .....	Sections 551 and 552
Precast Prestressed Concrete Piles ...	Sections 551 and 553

Fill steel pipe piles with concrete.

Furnish pile shoes meeting the Contract requirements.

### **559.03 CONSTRUCTION REQUIREMENTS.**

**559.03.1 Test Piles.** Drive test piles at the Contract locations or as directed.

Add to the test piles, the length shown on the plans below the cutoff elevation. Furnish the additional pile length to reach from the cutoff elevation to the pile position in the driving equipment. Increase the length at least 2 feet (600 mm) for timber piles and 1 foot (300 mm) for steel and concrete piles.

Use undamaged test piles as service piles in the completed structure. Excavate the ground at each test pile to plan grade before driving the pile. Drive test piles as specified in one continuous operation to practical refusal using the same equipment used to drive the service piles.

**559.03.2 Load Tests.** Perform load tests on test piles as specified.

**559.03.3 Furnishing Piles.** Once the test piles are driven, order piles using the Project Manager furnished order list. The list will designate the number, type, and length of piles required.

The listed lengths are those required below cutoff. Adjust the lengths for difference between cut off length and pile position in driving equipment. Increase timber pile length at least 2 feet (600 mm), and 1 foot (300 mm) for other piles. Remove and dispose of the excess length after driving.

Furnish all timber piling from the Project Manager's order list, meeting the requirements of Table 559-1.

**559.03.4 Driving Piles - General.** Drive all piles furnished under Subsection 559.03.3 to the depth set below cutoff or as directed.

Contract pile bearing requirements are based on design loadings and indicate the loads that the piles are to support. Pile bearings computed using the formulas in Subsection 559.03.5 are approximations only.

Drive each service pile in one continuous operation. Repair equipment break downs as soon as practical.

**TABLE 559-1  
DIMENSIONAL REQUIREMENTS OF TIMBER PILES<sup>1</sup>**

Length (ft) (m)	Diameter (Approx.)		Circumference			
	3 Ft (900 mm) From Butt		At Tip	3 Ft (900 mm) From Butt		At Tip
	Min	Max	Min	Min	Max	Min
	14-Inch (350 mm) Diameter Piles					
Under 40 12.2 m	14 350 mm	18 455 mm	9 230 mm	44 1120 mm	57 450 mm	28 710 mm
40 to 54 12.2 m 16.5 m	14 350 mm	18 455 mm	9 230 mm	44 1120 mm	57 1450 mm	28 710 mm
55 to 74 16.8 m 22.6 m	14 350 mm	18 455 mm	8 200 mm	44 1120 mm	57 1450 mm	25 635 mm
75 to 90 22.9 m 27.5 m	14 350 mm	20 510 mm	7 180 mm	44 1120 mm	63 1600 mm	22 560 mm
Over 90 <sup>2</sup> 27.5 m	—	—	—	—	—	—
12-Inch (300 mm) Diameter Piles						
Under 40 12.2 m	12 300 mm	20 510 mm	8 200 mm	38 965 mm	63 1600 mm	25 635 mm
40 to 54 12.2 m 16.5 m	12 300 mm	20 510 mm	7 180 mm	38 965 mm	63 1600 mm	22 560 mm
55 to 74 16.8 m 22.6 m	13 330 mm	20 510 mm	7 180 mm	41 1040 mm	63 1600 mm	22 560 mm
75 to 90 22.9 m 27.5 m	13 330 mm	20 510 mm	6 150 mm	41 1040 mm	63 1600 mm	19 485 mm
Over 90 <sup>2</sup> 27.5 m	—	—	—	—	—	—

**NOTE:**

<sup>1</sup> Douglas fir, Hemlock, Larch, Pine, Spruce, or Tamarack

<sup>2</sup> Dimensions of piles over 90 ft. (27.5 m) in length are specified in the Contract.

Minimum pile penetrations are as follows:

1. Footings in natural ground 10 feet (3 m) below bottom of footing elevation;
2. Footings in embankments 10 feet (3 m) below natural ground.

The Project Manager may change the pile penetrations.

If piling cannot be driven to the required penetration using the pile hammer alone, hard-driving procedures may be required, or a lesser penetration may be accepted.

Locate piles as shown on the plans. The allowable tolerance from a plumb line is 1/4-inch (20 mm) per foot (1000 mm) of pile length. No additional compensation is allowed for re-driving to meet the tolerance.

Safe bearing values will be based on data gathered during driving operations. Soil characteristics, penetration, driving conditions, distribution, size, length, and weight of piles will be used to determine safe bearing values. The safe bearing values will not be less than the design loads specified, unless authorized.

When the bearing values cannot be obtained, stop the driving when the pile is approximately 2 feet (610 mm) above cutoff elevation. Allow the pile to setup for between 24 and 72 hours. Resume driving and calculate bearing values for each blow up to 5 blows. Drive the piles to a sound cutoff elevation.

**559.03.5 Driving Timber Piles.** Drive treated and un-treated timber piles using a steam, air, or a diesel hammer developing a minimum 12,000 ft-lb (16 kN-m) of energy per blow.

The following formulas determine the bearing values when piles are not driven to practical refusal:

For single-acting steam hammers, air hammers, and diesel hammers:

$$\begin{array}{ll} \text{(English)} & \text{(Metric)} \\ P = \frac{2 WH}{S + 0.1} & P = \frac{.05 WH}{.305 S + .00076} \end{array}$$

For double-acting steam hammers and air hammers:

$$\begin{array}{ll} \text{(English)} & \text{(Metric)} \\ P = \frac{2H(W + Ap)}{S + 0.1} & P = \frac{.05 H (W + Ap)}{.3055 + .00076} \end{array}$$

**Where:** P = safe load per pile in pounds (N)  
W = weight in pounds (N) of striking part of hammer  
H = height of fall in feet (m)  
A = area of piston in square inches (mm<sup>2</sup>)  
p = steam or air pressure in pounds per square inch (Pa) at hammer  
S = the average penetration in inches (m) per blow for the last 10 to 20 blows of the hammer

The variable **WH** is determined by the Department.

These formulas apply only when:

- a. The hammer is operating normally;
- b. The penetration is at a uniform rate;
- c. The pile head is not broomed or crushed;
- d. Followers are not used.

**559.03.6 Driving Steel Piles.** Drive steel H-piles and steel pipe piles using steam, air, or diesel hammers that develop a minimum 12,000 ft-lb (16 kN-m) of energy per blow. Drive piles to the specified depth, or as directed.

The safe bearing values for steel piles, not driven to the specified depth, may be approximated by the formulas specified for timber piles.

**559.03.7 Driving Precast Concrete and Prestressed Precast Concrete Piles.** Drive pre-cast concrete and pre-stressed pre-cast concrete piles using steam, air, or diesel hammers that develop 1 ft-lb (1.36 kN-m) of energy per blow for each pound (kilogram) of weight driven, but not less than 12,000 ft-lb (16 kN-m) of energy per blow unless otherwise directed. Drive all concrete piles to the specified depth, or as directed.

The safe bearing values for concrete piles may be approximated by the formulas specified for timber piles.

**559.03.8 Inspection of Piles.**

**A. Untreated Timber Piles.** Untreated timber piles will be inspected at the project.

**B. Treated Timber Piles.** Treated timber piles will be inspected for grade and condition at the treating plant before treatment by a certified Inspector. The Inspector will stamp each pile on the butt end leaving an impression, legible after treatment. The stamp will be copyrighted by the Inspector, and the impression filed with the Department.

The piles will be inspected again after treatment. The Inspector will stamp each pile on the butt end with a stamp differing from that used before treatment. This impression must also be filed with the Department.

The Inspector will prepare an itemized report of the pile inspection. The report will document treatment temperatures, quantity of preservative, time of treatment, lengths and sizes, total footage, and all other pertinent information.

Treated timber piles not stamped before and after treatment cannot be used in the work.

**C. Steel Piles.** Steel piles may be inspected at the rolling mill and will be inspected at the project.

Furnish 2 copies of the certified mill test reports showing the chemical and physical test results for each heat number of steel piles in the shipment.

Camber and sweep of steel piles must not exceed that calculated by the following formula:

$$\text{Maximum Camber or Sweep, in} = \frac{1/8 \text{ in (3.2 mm)} \times \text{pile length, ft (305 mm)}}{10 \text{ ft (3.05 m)}}$$

Damaged or bent piles will be rejected.

- D. Concrete Piles.** Concrete piles will be inspected at the fabricating plant and at the project.

**559.03.9 Excavation.** Complete excavation before driving piles.

Remove material forced up between piles to the plan elevation at Contractor expense before placing foundation concrete.

**559.03.10 Caps.** Protect the heads of all concrete and timber piles with caps.

Follow the pile manufacturer's recommendations regarding driving heads, mandrels, or other required devices.

Cut steel piling heads squarely and provide a driving cap. Hold the pile axis in line with the axis of the hammer.

**559.03.11 Collars.** Provide collars, bands, or other devices when required.

**559.03.12 Pointing.** Point timber piles when required.

**559.03.13 Metal Shoes.** Provide piles with metal shoes when required.

**559.03.14 Splicing Piles.** Use full-length piles where practical.

Perform welding meeting the contract requirements for splicing steel piles or shells.

**559.03.15 Hard-Driving Procedures.** Hard driving is sustained driving beyond practical refusal to the point that pile damage is likely and imminent, and requires methods other than the pile hammer to obtain required penetration in natural ground.

The Project Manager will determine practical refusal, considering the type and size of piling, soil conditions, and the type and size of the pile hammer. Practical refusal is a penetration of 1 to ½-inch (25 to 10 mm) per 10 blows for wood piles and from ¾ to ¼-inch (20 to 5 mm) per 10 blows for steel piles.

Sustained driving is driving for more than 2 feet (600 mm) of penetration at blow counts in excess of those stated above.

Use hard driving procedures when directed. These procedures may include the use of pile shoes and pile reinforcement, drilling and shooting, pre-boring, jetting, punching, or using a different type or size of pile hammer, to reach the specified penetration without pile damage.

**559.03.16 Alignment.** Maintain pile alignment during pile driving. The Project Manager will suspend driving should the pile alignment fluctuate during driving.

**559.03.17 Followers.** Use followers only with the Project Manager's written permission. When requesting to use a follower, include detailed drawings of the proposed equipment. If a follower is used, drive one pile from each group of 10 as a long test pile, driven without a follower.

**559.03.18 Special Pile Driving Methods.** Request permission to use water jetting, pre-bore, or other special pile driving methods at least 2 working days before pile driving is to begin. Detail in the request the equipment and its use in the work. Assume all cost associated with special pile driving.

Pre-bore, when specified, is measured and paid for separately.

**559.03.19 Defective Piles.** Drive piles without crushing or spalling the concrete piles, splitting, splintering, or brooming wood piles, or deforming steel piles. Repair or replace all piles damaged during driving at Contractor expense.

Concrete pile with visible cracks or defects that may affect the strength or life of the pile will be rejected.

**559.03.20 Storage and Handling of Timber Piles.** Store and handle treated piles to prevent breaking or damaging the surface. Do not use cant hooks, dogs, or pike poles.

Treat surface cuts or breaks on treated piling and all bolt holes with 3 applications of copper naphthenate containing a minimum of 2% copper metal or with chromated copper arsenate (CCA) under AWP A M4.

**559.03.21 Cutting Off Timber Piles.** Saw the tops of all timber piles to the elevation provided by the Project Manager. Saw piles supporting timber caps or grillage to match the bottom plane of the superimposed structure. Provide the pile length above the cutoff elevation to permit the complete removal of all material injured by driving. Remove the damaged material from piles driven close to the cutoff elevation.

Treat the cut heads of all treated timber piles with 3 applications of a solution of copper naphthenate containing a minimum of 2% copper metal or with chromated copper arsenate (CCA) following AWP A M4.

Dispose of all pile cutoffs.

**559.03.22 Cutting Off Steel or Steel Pipe Piles.** Cut piles off at the required elevation. If capping is required, make the connection as specified.

Dispose of all pile cutoffs.

**559.03.23 Cutting Off Precast Concrete and Precast Prestressed Concrete Piles.** Cut off precast concrete and precast prestressed concrete piles at the required elevations. Cap, if required, as specified in the Contract.

Dispose of all concrete pile cutoffs.

**559.03.24 Piles Cast in Place and Steel Pipe Piles.** Construct cast-in-place piles as specified.

Fill steel pipe piles with the specified class of concrete.

Provide lights for inspecting concrete placement in the steel pipe piles. Provide lighting to illuminate the full pile length.

Correct or replace all improperly driven, broken, or otherwise defective piles at Contractor expense.

Remove all water in steel pipe piling before placing concrete.

Do not drive pile within a 15 feet (4.5 m) radius of the concrete work or begin pile driving until all the piling for any one bent has been completely driven. Resume driving in the above areas after the concrete in the last pour has set at least 7 days.

**559.03.25 Extensions or Build-Ups.** Make extensions, splices, or build-ups on precast concrete or precast prestressed concrete piles as follows:

Once driving is completed, remove the concrete pile end, leaving the pile reinforcing steel exposed for a length of 40 diameters. Finish cut the pile top normal to the pile axis. Splice reinforcing steel matching that in the pile to the projecting pile steel and place the form work.

Use the same concrete mix design for the pile top as used in the pile. Thoroughly wet and coat the pile top with a thin coating of neat cement or other approved bonding material before placing concrete. Leave the forms in place at least 7 days. Finish the extension surface to match the original pile.

Construct steel pile extensions by splicing on additional sections of steel piling. Make splices as specified or directed.

**559.03.26 Painting Steel Piles and Steel Pile Shells.** Paint piles starting 2 feet (600 mm) below the water level or ground surface to the top of the exposed steel.

- A. Paint.** Furnish paint meeting Subsection 710.02 (B)(4) requirements.
- B. Surface Preparation.** Prepare the pipe pile surface to be painted following the paint manufacturer's recommendation's.
- C. Painting.** Follow all the paint manufacturer's recommendations for paint application. Shop apply the first 2 paint coats for the pipe pile to produce a minimum 12 mil (300  $\mu\text{m}$ ) dry film thickness. Do not paint over pile markings for certification until they are inspected against the certifications. Provide a painter's certification that the paint was applied following the manufacturer's recommendations and certified test results showing the coating thickness on the piles.

Repair coating damage due to transport and handling in the field following the paint manufacturer's recommendations before applying the finish coat.

Use the same paint or a paint compatible with the first 2 paint coats as a finish coat. Paint the finish coat providing a minimum 4 mils (75  $\mu\text{m}$ ) dry film thickness from the groundline to the point the pile is embedded in concrete. The Project Manager will select the finish coat color.

#### **559.04 METHOD OF MEASUREMENT.**

**559.04.1 Test Piles.** Test piles are lump sum. Base the lump sum bid price on the test pile quantity specified in the Contract. If the quantity is increased or decreased during construction, the lump sum bid price will be increased or decreased using the following formula:

$$\begin{array}{l} \text{Dollar Amount of Increase or} \\ \text{Decrease in Lump Sum Bid Price} \end{array} = (a \times c) + (b \times d)$$

**Where:** **a** = Length of test pile required below cutoff elevation, ft (meter)  
**b** = "a" minus footing embedment, ft (meter)  
**c** = Unit price bid for furnishing piling, \$ per linear foot (meter)  
**d** = Unit price bid for driving piling, \$ per linear foot (meter)

**559.04.2 Load Tests.** Load tests are measured by each completed and accepted test made.

**559.04.3 Furnishing Piles.** Furnished piles are measured in linear feet (meters) computed from the Project Manager's order list, as specified in Subsection 559.03.3. If an order list is not furnished, the measured quantity is the total linear feet (meter) of piling driven, measured to the nearest foot (305 mm). The required pile length increase between cut-off and position in driving equipment furnished under Subsection 559.03.3, is not measured for payment.

**559.04.4 Driving Piles.** Driving pile are measured by the linear feet (meter) of piling driven below the bottom of the substructure units or below the bottom of pre-bore holes when pre-boring is required. Driving is measured to the nearest foot (305 mm).

**559.04.5 Pre-boring Holes for Piles.** Pre-boring holes are measured by the linear feet (meter) drilled below the bottom of the substructure units. Pre-boring is measured to the nearest foot (305 mm).

**559.04.6 Pile Splices.** Pile splices are measured as the number of pile splices specified in the Contract.

Splicing permitted for Contractor convenience to meet order list lengths, to suit driving conditions, or for other reasons is not measured.

**559.04.7 Pile Shoes.** Pile shoes are measured as the total number specified in the Contract or authorized by the Project Manager.

**559.04.8 Extensions or Build-ups.** Extensions or build-ups are measured by the total linear feet (meter) specified in the Contract or ordered in writing by the Project Manager.

Measurement is to the nearest foot (305 mm).

**559.04.9 Filler Concrete.** Filler concrete is measured by the cubic yard (cubic meter).

**559.04.10 Piles.** Piles are measured by the piles furnished and placed when the Contract specifies payment to be made on a per each basis.

**559.04.11 Hard Driving.** Hard driving is measured for payment by the linear feet (meter) of piling driven into natural ground using hard-driving procedures described in Subsection 559.03.15. Hard driving is measured to the nearest foot (305 mm).



Penetration of hard layers 2 feet (610 mm) or less in thickness using the pile hammer alone is not measured as hard driving but is measured under Subsection 559.04.4.

**559.05 BASIS OF PAYMENT.** Payment for the completed and accepted quantities is made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
Test Piles	Lump Sum
Load Test	Each
Furnishing Piles	Linear Foot (meter)
Driving Piles	Linear Foot (meter)
Pre-bore Holes	Linear Foot (meter)
Pile Splices	Each
Pile Shoes	Each
Extensions/Buildups	Linear Foot (meter)
Filler Concrete	Cubic Yard (cubic meter)
Hard Driving	Linear Foot (meter) or Force Account

**559.05.01 Falsework and Defective Piles.** No payment is made for furnishing or driving falsework piles, piles driven out of place, defective piles, or piles that are damaged in handling or driving.

**559.05.02 Additional Requirements.** Brackets, plates, or other reinforcement on steel piles required by the Project Manager in addition to that in the Contract is paid for as extra work.

No separate payment is made for painting exposed portions of steel piles or steel pile shells.

**559.05.03 Piles Ordered and Not Driven.** Piles purchased on the Project Manager's itemized list but not incorporated in the finished structure are paid at invoice prices. Deliver to the location designated by the Project Manager.

**559.05.04 Progress Payments.** The following percentages of the total quantity of piles driven are allowed for payment on progress estimates:

1. 95 percent when driven to final penetration;
2. 100 percent when cut off in compliance with the Contract.

Payment at the contract unit price is full compensation for all resources necessary to complete the item of work under the Contract.